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A new subgenus and a new species of *Simulium* s. l. (Diptera: Simuliidae) from Thailand

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Abstract: *Simulium oblongum* sp. nov. is described based on female, male, pupal and larval specimens collected in Thailand. This new species is characterized by the genitalia of both sexes, especially the elongated cercus in the female and the absence of parameral hooks in the male; the pupal gill with a dendroid type of 31–33 slender filaments; the larval antenna subequal in length to the stem of the labral fan. Based on a combination of these distinctive characteristics observed in this new species, a new subgenus, *Asiosimulium*, is proposed within the genus *Simulium* s. l.

Key words: black fly, Simuliidae, *Simulium*, Thailand, new species, *Asiosimulium*

In Thailand, a total of 44 black-fly species (Diptera: Simuliidae) have been recorded, which are classified into five subgenera in the genus *Simulium* Latreille s. l.: *Daviesellum* Takaoka and Adler, *Gomphostilbia* Enderlein, *Montisimulium* Rubtsov, *Nevermannia* Enderlein and *Simulium* Latreille s. str. (Takaoka and Choochote, 2004). During recent surveys on black flies in Northeast Thailand, we collected a new species of the genus *Simulium* s. l. which shows several remarkable characteristics so far never or rarely reported in the family Simuliidae. This new species is described based on the reared female, male, pupa and mature larvae, and a new subgenus is proposed for this unique species.

The terms for morphological features used here follow those of Takaoka (2003). Holotype and paratype specimens of the new species are deposited at the Department of Infectious Disease Control, Oita University.

Simulium (*Asiosimulium*) *oblongum* subg. nov. and sp. nov.

DESCRIPTION. **Female.** Body length 3.0–3.2 mm. ***Head.*** Slightly narrower than thorax. Frons brownish black, thinly whitish-grey pruinose, not shiny, densely covered with yellowish white hairs (except median longitudinal portion very narrowly bare) interspersed with several dark longer and stouter hairs along each lateral margin; median suture on lower portion absent (Fig. 1A); frontal ratio 1.6 : 1.0 : 1.6. Frons-head ratio 1.0 : 4.0. Fronto-ocular area (Fig. 1A) well developed, triangular, directed laterally. Clypeus brownish black, thinly whitish-grey pruinose, slightly shiny at certain angle of light, densely covered with yellowish white hairs (except narrow portion near upper margin bare) intermixed with several dark longer and stouter hairs along lateral margins and near lower margin. Labrum 0.65 times as long as clypeus. Antenna composed of 2+9 segments, blackish brown, except scape, pedicel, and base of 1st flagellar segment yellow; 1st flagellar segment 1.4 times as long as 2nd one. Maxillary palp consisting of 5 segments, medium brown except 3rd segment blackish brown, proportional lengths of 3rd, 4th, and 5th segments 1.0 : 1.0 : 1.7; 3rd segment somewhat enlarged; sensory vesicle (Fig. 1B, C) ellipsoidal, 1.5 times as long as wide, and 0.36 times as long as 3rd segment, with large opening. Lacinia with 10 or 11 inner and 12–14 outer

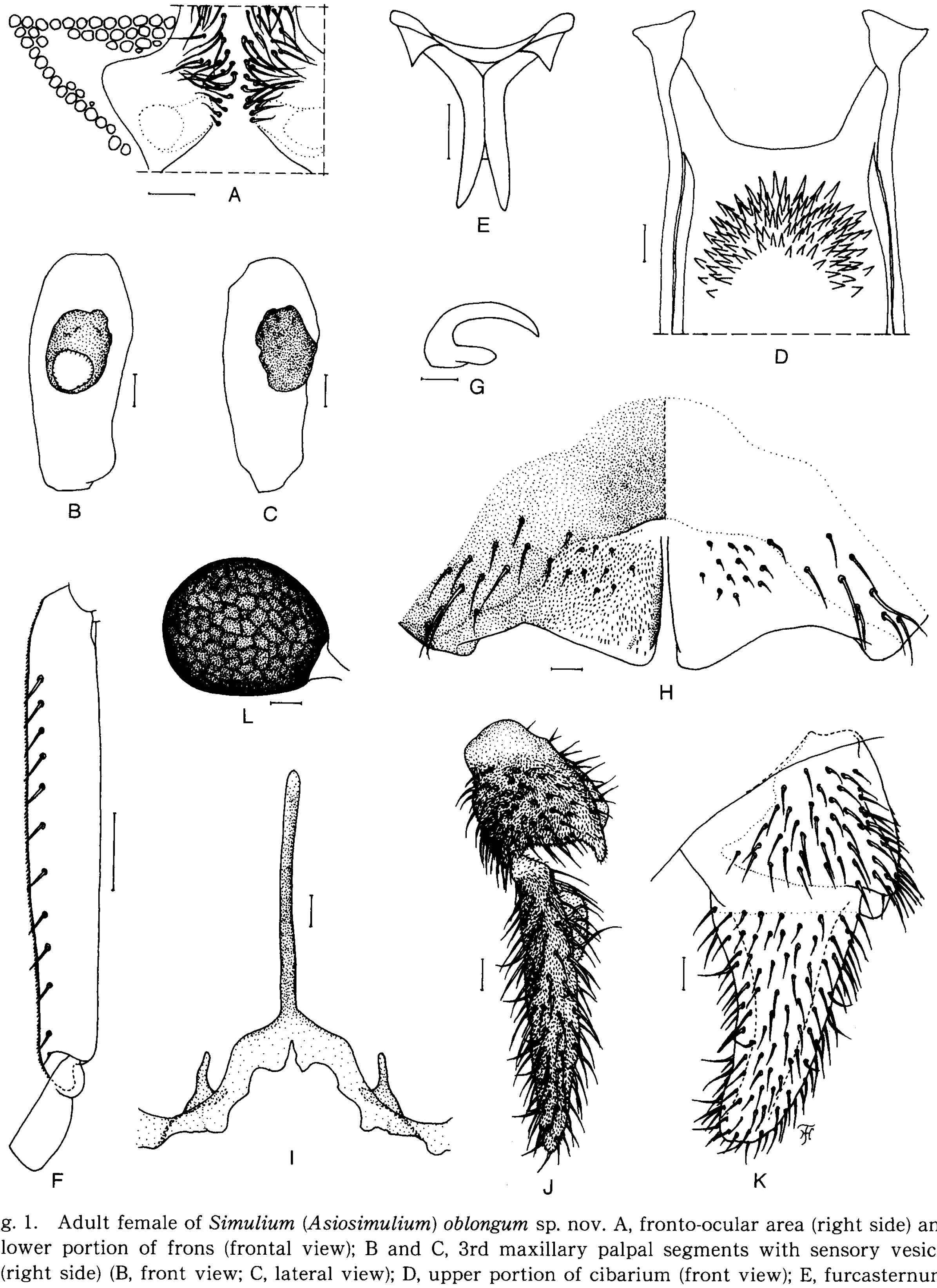

Fig. 1. Adult female of *Simulium* (*Asiosimulium*) *oblongum* sp. nov. A, fronto-ocular area (right side) and lower portion of frons (frontal view); B and C, 3rd maxillary palpal segments with sensory vesicle (right side) (B, front view; C, lateral view); D, upper portion of cibarium (front view); E, furcasternum; F, hind basitarsus and 2nd tarsal segment (left side, outer view); G, claw; H, 8th sternite, ovipositor valves; I, genital fork (ventral view); J and K, paraprocts and cerci (right side) (J, ventral view; K, outer view); L, spermatheca (lateral view). Scales. 0.1 mm for E and F; 0.05 mm for A; 0.02 mm for B–D, G and H–L.

teeth. Mandible with 22–24 inner and 8–10 outer teeth. Cibarium (Fig. 1D) with ca. 100–120 spinous processes elaborately arranged on anterior surface somewhat apart from posterior margin. ***Thorax.*** Scutum medium to dark brown (except anterolateral calli light brown), with 3 brownish black narrow londitudinal vittae (1 median, 2 submedian), shiny at certain angle of light, and densely covered with yellowish white short hairs mixed with several dark upright long hairs on prescutellar area. Scutellum medium brown, with many dark upright long hairs as well as yellowish white short hairs. Postnotum dark brown, slightly shiny at certain angle of light, bare. Pleural membrane bare. Katepisternum longer than deep, dark brown, shiny in light and bare. Furcasternum (Fig. 1E) with distinct ventrally-directed apodemes on internal dorsal arms. ***Legs.*** Fore and hind coxae, and all trochanters and femora light to medium brown except apical cap of femora dark brown; and mid coxa, and all tibiae and tarsi brownish black to black except extreme base of tibiae yellow and lateral surfaces of fore and mid tibiae somewhat lighter medially. Fore basitarsus moderately dilated, about 6.1 times as long as its greatest width, and with moderate dorsal hair crest. Hind basitarsus (Fig. 1F) nearly parallel-sided on basal 2/3, then somewhat narrowed toward apex, 6.7 times as long as its greatest width, 0.7 and 0.6 times as wide as the greatest widths of tibia and femur, respectively; calcipala well developed, slightly shorter than its width at base, and about half or a little more as wide as apical portion of basitarsus; pedisulcus well developed. All claws (Fig. 1G) each with large basal tooth 0.55 times as long as claw. ***Wing.*** Length 2.3 mm. Costa with 2 parallel rows of dark short spines as well as dark hairs. Subcosta with dark hairs except near apex bare. Hair tuft on stem vein dark. Basal portion of radius fully haired. R_1 with dark spinules and hairs. R_2 with dark hairs only. Basal cell, and basal median cell absent. ***Abdomen.*** Basal scale medium to dark brown, with fringe of yellowish white long hairs. Dorsal surface of abdomen medium to dark brown (posterior segments darker except all tergites dark brown), densely covered with yellowish white short hairs interspersed with dark hairs (each lateral surface of segments 2–7 also densely covered with yellowish white hairs); tergites 5–8 shiny at certain angle of light; ventral surface of abdomen dark ocherous on segments 2–4 (or 5), light to medium brown on other posterior segments; segment 7 with large sternal plate medially. ***Genitalia.*** Sternite 8 (Fig. 1H) wide, bare medially but furnished with 10–13 short and medium-long hairs on each side. Ovipositor valve (Fig. 1H) nearly triangular, thin, membranous (except inner margin narrowly sclerotized), densely covered with microsetae (except narrow portion along posterior margin bare) interspersed with 9–12 short hairs; inner margins nearly straight, narrowly separated from each other. Genital fork (Fig. 1I) inverted-Y-shaped, with well sclerotized stem and wide arms, and with a narrow deep incision between arms; each arm with a distinct projection directed anterodorsally on dorsal surface. Paraproct (Fig. 1J, K) of usual shape, only slightly protruding ventrally (in lateral view), with numerous short and medium-long hairs on ventral and lateral surfaces, and with 14 or 15 spinous colorless sensilla on sclerotized anteromedial surface. Cercus (Fig. 1J) elongate, much longer than paraproct, rounded outwardly (in ventral view), and with numerous short and medium-long hairs; cercus in lateral view (Fig. 1K) gradually narrowed posteriorly, with rounded apex, about twice as long as its width at base. Spermatheca (Fig. 1L) ovoidal, strongly sclerotized (except area around its junction with duct unsclerotized), with distinct reticulate surface pattern, and with internal setae; accessory ducts subequal in diameter to each other and slightly larger in diameter than that of main duct.

Male. Body length 2.7 mm. ***Head.*** Slightly wider than thorax. Holoptic. Upper eye consisting of large facets in 19 vertical columns and 19 horizontal rows. Clypeus brownish black, white pruinose, and moderately covered with dark simple long hairs interspersed with pale shorter hairs (median portion widely bare). Antenna composed of 2+9 segments; dark brown to brownish black except scape, pedicel, and base of 1st flagellar segment pale yellow; 1st flagellar segment elongate, 1.8 times as long as 2nd one. Maxillary palp composed of 5 segments, light to medium brown, proportional lengths of 3rd, 4th, and 5th segments 1.0 : 1.1 : 1.9; 3rd segment of moderate size; sensory vesicle (Fig. 2A) globular or slightly ellipsoidal, about 0.15 times as long as 3rd segment. ***Thorax.*** Nearly as in female except short hairs on scutum and scutellum whitish yellow. ***Legs.***

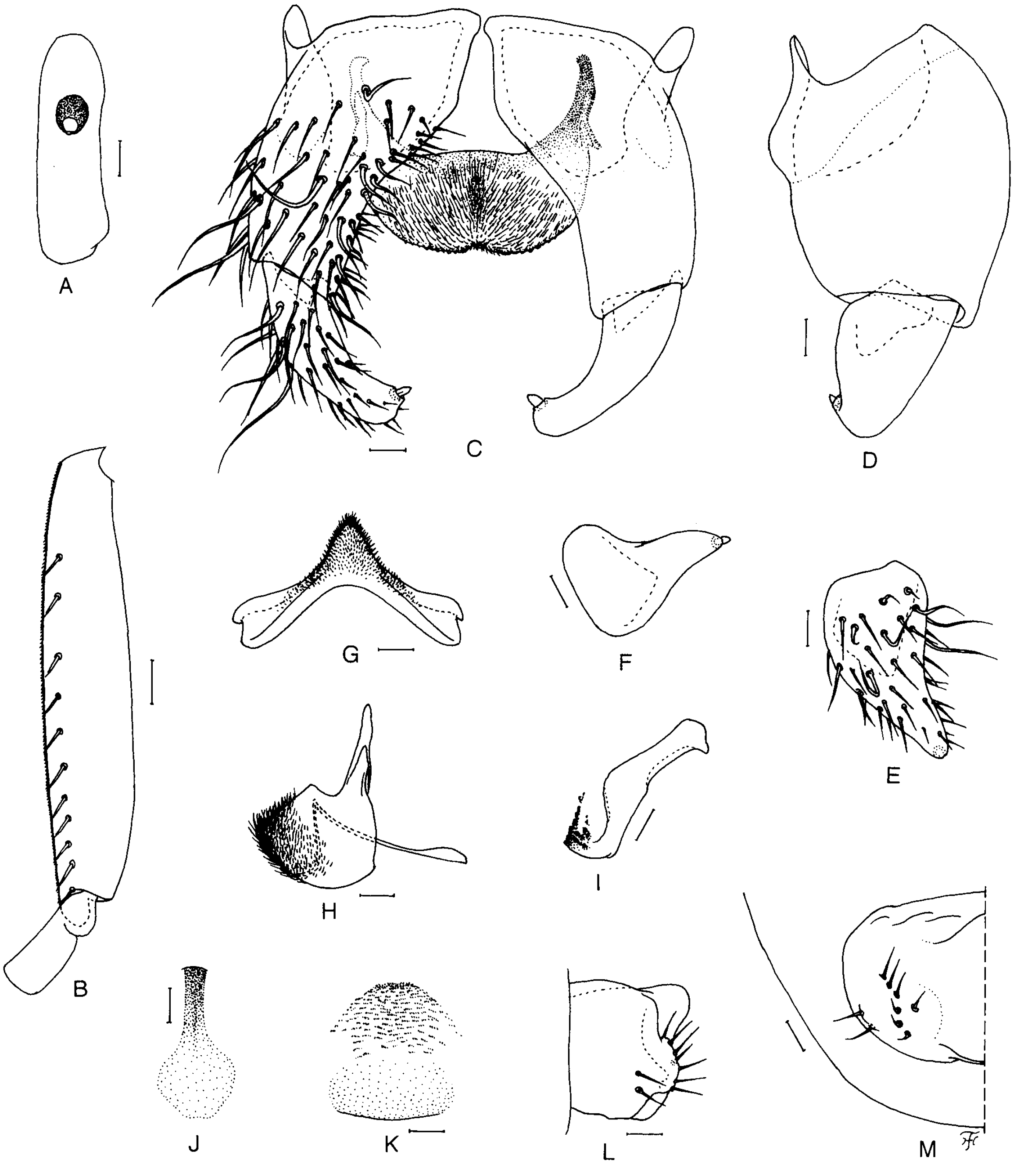

Fig. 2. Adult male of *Simulium* (*Asiosimulium*) *oblongum* sp. nov. A, 3rd segment of maxillary palp (right side, frontal view); B, hind basitarsus and 2nd tarsal segment (left side, outer view); C, coxites, styles and ventral plate *in situ* (ventral view); D, coxite and style *in situ* (right side, lateral view); E and F, styles (right side) (E, posterolateral view; F, end view); G, ventral plate (end view); H, ventral plate and median sclerite (lateral view); I, paramere (left side, end view); J, median sclerite (end view); K, aedeagal membrane and dorsal plate (end view); L and M, 10th abdominal segments and cerci (L, right side, lateral view; M, right half, end view). Scales. 0.05 mm for B; 0.02 mm for A and C–M.

Color nearly as in female. Fore basitarsus cylindrical, somewhat dilated, about 7.3 times as long as its greatest width. Hind basitarsus (Fig. 2B) slightly spindle-shaped, 5.4 times as long as its greatest width, 0.75 and 0.62 times as wide as the greatest widths of hind tibia and femur, respectively; calcipala (Fig. 2B) well developed, nearly as long as its width at base, and 0.32 times as wide as the grestest width of basitarsus; pedisulcus well developed. ***Wing.*** Length 1.9 mm. Other characters as in female except subcosta bare. ***Abdomen.*** Basal scale brownish

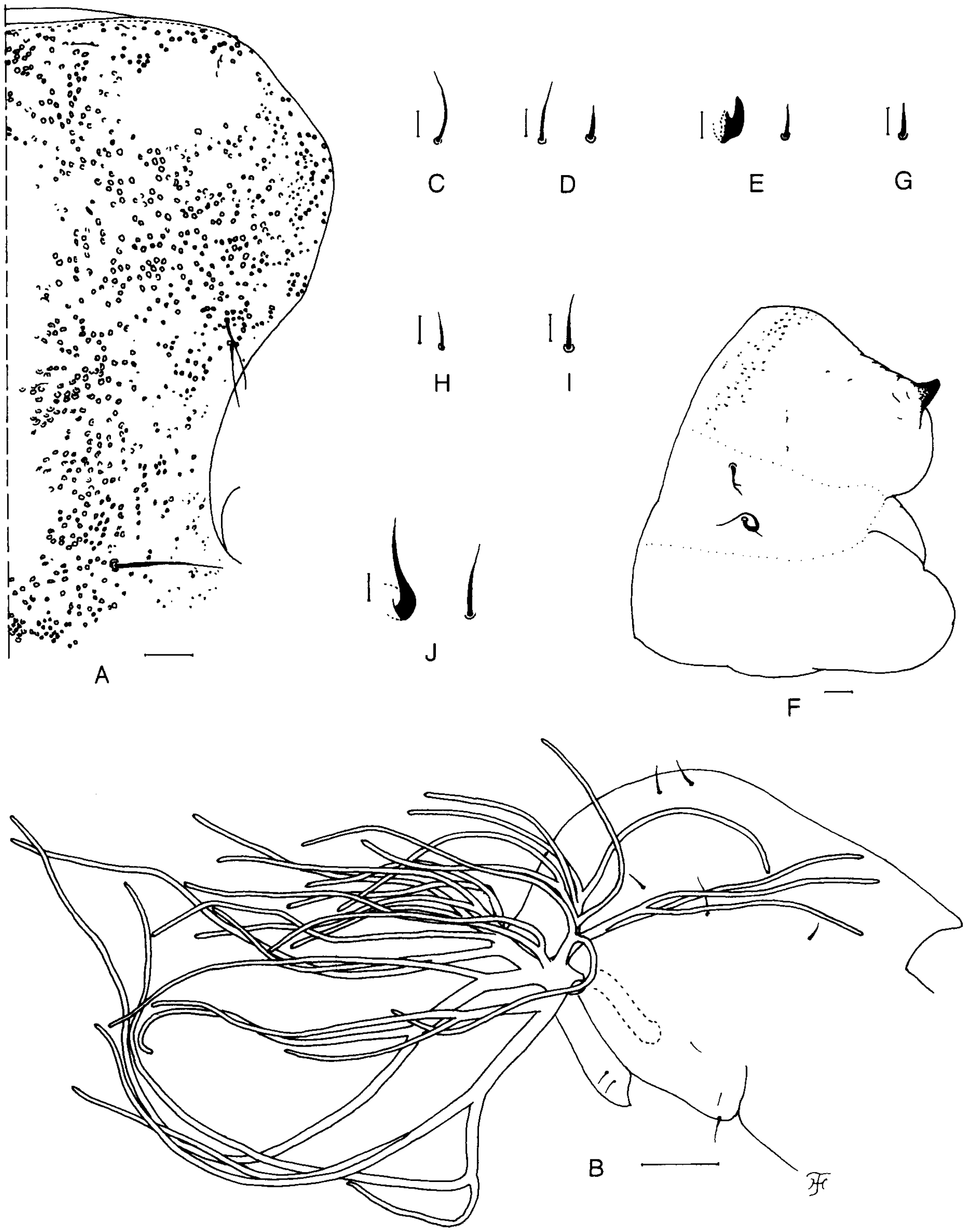

Fig. 3. Pupa of *Simulium* (*Asiosimulium*) *oblongum* sp. nov. A, frons and upper part of face (female, left half); B, pupal gill filaments (left side, outer view); C, hair on dorsal surface of abdominal segment 1; D, hair and spine on dorsal surface of abdominal segment 2; E, hook and spine on dorsal surface of abdominal segment 3; F, last segment of abdomen (female pupa) showing terminal hook and 2 spines (outer view); G, spine on lateral surface of abdominal segment 4; H and I, spines on ventral surface of abdominal segments 3 and 4; J, hook and spine on ventral surface of abdominal segment 5. Scales. 0.2 mm for B; 0.05 mm for A; 0.02 mm for C–J.

black with fringe of dark long hairs. Dorsal surface of abdomen entirely brownish black (except base of 2nd segment pale), with tergite 2 whitish pruinose, and shiny at certain angle of light, and moderately covered with dark simple hairs. ***Genitalia.*** Coxite (Fig. 2C, D) subquadrate, much longer than wide. Style (2C–F) short, 0.67 times as long as coxite, tapered apically, bent inward, rounded apically, and with a spine at apex when viewed ventrally; style broad on basal 1/2, then abruptly tapered apically when viewed posterolaterally. Ventral plate (Fig. 2C, G, H) lamellate, much shorter than wide, well sclerotized (in particular anterior margin and arms), rounded posterolaterally, with posterior margin concave medially when viewed ventrally, and moderately covered with fine short setae on ventral and posterior surfaces (except each lateral area on ventral surface bare); arm of moderate length, slender, directed forwardly, with apex bent inwardly. Paramere (Fig. 2I) narrow, without parameral hook. Median sclerite (Fig. 2J) narrow basally, then widened apically. Aedeagal membrane (Fig. 2K) with simple minute spines, and with weakly sclerotized broad dorsal plate (Fig. 2K) basally. Ventral surface of 10th segment without any hair. Cercus (Fig. 2L, M) small, very low in lateral view, encircled with 9–11 simple hairs.

Pupa. Body length 3.5–4.0 mm. ***Head*** (Fig. 3 A). Integument dark yellow to light brown, moderately covered with tubercles of various sizes; frons with 2 medium-long stout simple trichomes lying close together on each side, face with 1 long stout simple trichome (ca. 1.4 times as long as frontal trichomes) on each side. ***Thorax*** (Fig. 3B). Integument dark yellow to light brown, moderately covered with round tubercles, with 2 long stout simple trichomes mediodorsally, 2 stout simple trichomes (1 long, 1 medium-long) mediolaterally, 1 medium-long stout simple trichome posterolaterally, and 3 simple trichomes (1 medium-long, 2 short or medium-long) ventrolaterally, on each side. Gill (Fig. 3B) composed of 31–33 slender thread-like filaments arranged in 5 or 6 groups arising from base; number and configurations of filaments somewhat different by individual pupae, especially in 1st and/or 2nd groups from dorsal, e.g., (3+3)+(3+2)+2+(2+2+1+2+2)+3+[2+(2+2)] filaments from dorsal to ventral in case of 31 filaments, (3+3)+(4+2)+2+(2+2+1+2+2)+3+[2+(2+2)] filaments in case of 32 filaments, and [(2+2)+3]+[(4+2)+2]+(2+2+1+2+2)+3+[2+(2+2)] filaments in case of 33 filaments; all filaments medium brown, variable in length from 0.4 mm to 2.0 mm, with annular ridges and furrows almost throughout their lengths, and densely covered with minute tubercles. ***Abdomen.*** Dorsally, all segments weakly or moderately sclerotized and yellowish or yellowish brown; segment 1 sparsely tuberculate, with 1 medium-long stout simple dark hair (Fig. 3C) on each side; segment 2 moderately tuberculate, with 1 medium-long stout simple dark hair and 5 short dark spines (Fig. 3D) on each side; segments 3 and 4 each with 4 dark stout hooks and 1 short dark spine (Fig. 3E) on each side; segments 5–9 each with comb-like groups of minute spines lying transversely along anterior margin (though very sparsely on segment 5) on each side, and lacking spine-combs; segments 5–8 each with 2 pairs of short dark or pale spines along posterior margin on each side; terminal hooks distinct, cone-shaped (Fig. 3F). Laterally, segments 2–4 each with 3 short dark spines (Fig. 3G) on each side; segments 6–8 each with 2 or 3 short dark or pale spines on each side; segment 9 with 1 or 2 short simple or bifid dark spines on each side (Fig. 3F). Ventrally, segments 3–7 nearly transparent and segments 8 and 9 weakly or moderately sclerotized and yellow to yellowish brown; segments 4–8 with comb-like groups of minute spines; segment 3 with 3 short dark simple spines (Fig. 3H) on each side; segment 4 with 4 simple dark spines (Fig. 3I) on each side; segments 5–7 each with 2 stout simple (or rarely bifid apically) dark hooks and 2 short simple dark hair-like spines (Fig. 3J) on each side. ***Cocoon.*** Wall-pocket-shaped, somewhat roughly woven, with no or small open spaces in webs anteriorly, without anterodorsal projection, and not extending ventrolaterally; anterior margin not thickly woven; individual threads visible; 3.2–3.8 mm long by 2.0–2.2 mm wide.

Mature larva. Body length 6.2–6.8 mm. Body color greyish; abdomen gradually widened toward segment 6 or border between segments 6 and 7 when viewed dorsally (toward segment 7 when viewed laterally), then narrowed posteriorly. Cephalic apotome whitish on anterior 1/2, whitish yellow on posterior 1/2 (though its border not well defined) and darkened along posterior margin, with well-defined positive head-spots, of which posterior one of 2 posterolateral spots completely merged in dark background color, and posterior tip of posteromedial longitudinal spots also narrowly or completely connected to dark background color; lateral surface of head capsule somewhat darkened except eye-spot region and anterior portion whitish or whitish yellow; eyebrow moderately defined; 2 large and 1 small spots near posterior margin and 2 small spots just below eye-spot region distinctly positive, though 2 large spots sometimes merged in dark background color; ventral surface of head

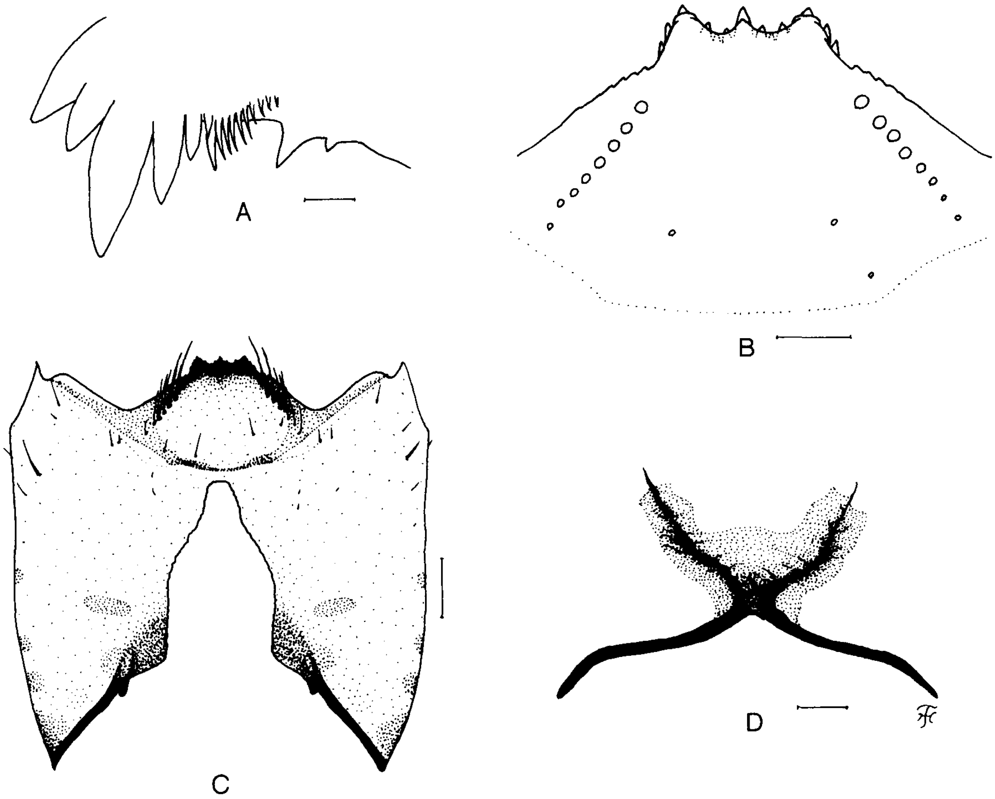

Fig. 4. Mature larva of *Simulium* (*Asiosimulium*) *oblongum* sp. nov. A, apex of mandible (left side); B, hypostomium (ventral view); C, head capsule showing deep postgenal cleft (ventral view); D, anal sclerite. Scales. 0.1 mm for C; 0.05 mm for B and D; 0.01 mm for A.

capsule dark yellow, with dark basal area on each side of postgenal cleft; horizontal and round spots on each side of postgenal cleft distinctly positive. Cervical sclerites composed of 2 small elliptical pieces, not fused to occiput, very widely separated medially from each other. Antenna consisting of 3 segments and apical sensillum, subequal in length to stem of labral fan; proportional lengths of 1st, 2nd, and 3rd segments 1.0 : 1.3 : 1.0. Labral fan with 43–45 main rays. Mandible (Fig. 4A) with mandibular serrations consisting of 2 teeth (1 large, 1 small); large tooth at a right angle to mandible on apical side; comb-teeth composed of 3 teeth decreasing in size from 1st to 3rd; supernumerary serrations absent; mandibular phragma extended to maxilla base. Hypostomium (Fig. 4B) with 9 apical teeth in row; median and corner teeth well developed; median tooth of 3 intermediate teeth on each side smallest; lateral serrations weakly developed anteriorly; 7 or 8 hypostomal bristles per side, lying slightly divergent posteriorly from lateral margin. Postgenal cleft (Fig. 4C) deep, leaving narrow bridge up to posterior margin of hypostomium, nearly parallel-sided on basal 1/2, then converged apically forming round extension. Prothoracic proleg with dorsolateral sclerite well defined. Abdominal cuticle bare except both sides of anal sclerite moderately covered with simple colorless setae. Rectal scales not discernible. Rectal organ compound, each of 3 lobes with 7–11 finger-like secondary lobules. Anal sclerite (Fig. 4D) X-shaped, with anterior arms 0.7 times as long as posterior ones; anterior arms broadened, and space between arms widely sclerotized basally; 2–10 sensilla just posterior to basal junction area; accessory sclerite absent. Last abdominal segment somewhat expanded ventrally forming ventral bulge, visible as a very small ventral papilla when viewed from side. Posterior circlet with ca. 76 rows of up to 15 hooklets per row.

TYPE SPECIMENS. Holotype female (emerged from a pupa) with its associated pupal exuvia and cocoon, collected at Phu Hung, Muang District, Muk Da Han Province, Northeast Thailand, 20.X.2004, by W. Choochote. Paratypes: 2 females and 1 male with their associated pupal exuviae and cocoons, 2 pupal exuviae and 2 mature larvae, same data as holotype.

ECOLOGICAL NOTES. The pupae and larvae of this new species were found on the surface of leaves and stalks of trailing grasses, and also on the surface of rocks in a small slow-flowing lowland stream (width 0.8 m, depth 0.03 m, stream bed rocky, covered with reddish muds, water temperature 29℃, exposed to the sun, altitude 270 m). Associated species was *Simulium* (*Nevermannia*) *aureohirtum* Brunetti.

DISTRIBUTION. Thailand.

ETYMOLOGY. The specific name *oblongum* is based on the Latin word "oblongus" meaning "longer than wide", with spelling changed to oblongum to conform with the neuter gender of *Simulium*, and it refers to the proportion of the elongated cercus.

REMARKS. *Simulium oblongum* sp. nov. is readily assigned to the genus *Simulium* s. l. by having a combination of the following characteristics: in both sexes of adults, costal vein with spinules as well as hairs, radial sector not forked, basal median cell absent, furcasternum with internal dorsal arms bearing ventrally directed apodeme, hind basitarsus well developed calcipala, and second tarsal segment of hind tarsus with distinct pedisulcus; in the pupa, terminal hooks cone-shaped, cocoon wall-pocket-shaped; in the larva, hypostomal teeth rather low, median tooth not trifid.

It is striking that *S. oblongum* is characterized in the female by the cibarium with numerous spines (Fig. 1D) and very long cercus (Fig. 1J, K), both characteristics never before reported in any other known species of Simuliidae; in the male by the absence of parameral hooks (Fig. 2I), which is a key characteristic of the subgenus *Morops* Enderlein in the Australasian Region (Takaoka, 2003), and is also found in several species of other subgenera of the genus *Simulium* s. l., and of other genera like *Prosimulium* Roubaud (Adler et al., 2004); in the pupa by the dendroid type of 31–33 gill filaments (Fig. 3B), a type also occurring very rarely in *Simulium* s. l. species in the Oriental and Australasian Regions [only one species of the subgenus *Morops*, *S. papuense* Wharton, has such a dendroid type of ca. 45 gill filaments (Takaoka, 2003)], and abdomen dorsally without spine-combs on segments 5–9, a characteristic being very rarely seen in *Simulium* s. l. except a few subgenera including *Wallacellum* Takaoka in and around the Philippines (Takaoka, 2003); and in the larva by the short antenna subequal in length to the stem of the labral fan (usually longer in most species of *Simulium* s. l.)

This new species can not be satisfactorily assigned to any of the 45 subgenera of the genus (Adler et al., 2004; Coscarón, 1987; Crosskey, 1969; Crosskey and Howard, 1997; Rubtsov, 1956). This new species seems to be, however, related to three subgenera, *Boreosimulium* Rubtsov and Yankovsky in the Holarctic Region, *Inseliellum* Rubtsov in Micronesia and Polynesia, and *Nevermannia* Enderlein, a cosmopolitan subgenus, by having both katepisternum and pleural membrane bare, the basal portion of the radial vein haired, female claw with a large basal tooth (Fig. 1G), style much shorter than coxite (Fig. 2C, D), and ventral plate transverse (Fig. 2C). All the distinctive characteristics observed in *S. oblongum* and noted above differ from the diagnosis of all the three subgenera.

Here proposed is a new subgenus, *Asiosimulium* (*Asio* from the Latin adjective *Asius* meaning "Asian"), with *S. oblongum* as type species, and with its diagnosis as follows: in both sexes of adults, both katepisternum and pleural membrane bare, the basal portion of the radial vein haired, both calcipala and pedisulcus well developed (Figs. 1F and 2B); in the female, cibarium with numerous spines (Fig. 1D), claw with a large basal tooth (Fig. 1G), abdominal segments 5–8 shiny at certain angle of light, genital fork with arms broadened, each bearing a distinct apodeme directed anterodorsally (Fig. 1I), spermatheca ovoid, with polygonal surface patterns and internal setae (Fig. 1L); in the male, abdomen dull, without any shiny markings dorsally, style much shorter than coxite (Fig. 2C, D), ventral plate transverse, with anterior margin strongly sclerotized bearing no notch medially, and with setae on ventral and posterior surfaces (Fig. 2C, G), paramere without hooks (Fig. 2I), median sclerite simple, plate-like and broad subapically (Fig. 2J), aedeagal membrane with minute spine-like setae (Fig. 2K), dorsal plate subrectangular (Fig. 2K); in the pupa, gill with a dendroid type of numerous filaments (Fig. 3B), abdomen dorsally without spine-combs on segments 5–9, and ventrally with a pair of simple hooks (Fig. 3J) on each side of segments 5–7, terminal hook short, cone-shaped (Fig. 3F), last abdominal segment with 1 or 2 distinct strongly sclerotized spines on each lateral surface (Fig. 3F), cocoon wall-pocket-shaped; in the larva, mandible with 3 comb-teeth decreasing in size (Fig. 4A), hypostomium with the usual 9 anterior teeth, of which median and corner teeth prominently developed, and with serrated lateral margins (Fig. 4B), antenna subequal in length to stem of the labral fan, postgenal cleft deep (Fig. 4C), and ventral papillae very small.

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